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OIL PRICE SHOCKS AND THEIR CONSEQUENCES ON SUDAN'S GDP GROWTH AND UNEMPLOYMENT RATES

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Abstract

Since the advent of oil production and export in late 1999, Sudan economy became more reliant on oil exports proceeds. This situation has exposed the economy to the negative effect of oil price fluctuations. In general, oil exporting countries exhibit positive impact on their economy to oil price increase, while oil importing economies suffer. Unlike developing economies, there is a paucity of research in developing countries with regards to the relationship between the macro-economy and oil price shocks. In this regard, Sudan has been neglected from serious studies related to oil price shocks. This research attempts to contribute towards filling this gap. In doing so, Vector Auto-Regression model is employed to investigate the impact of oil price shocks on the real GDP growth and unemployment rates over the period 2000 - 2014. The Granger causality test suggests that unemployment has statistically and significantly influenced real GDP growth. Results from the Impulse Response Functions and Forecast Error Variance Decomposition analysis suggest that increase in real oil price has greater influence on GDP growth. Interestingly, real oil price decrease has a significant positive impact on unemployment rate.

Keywords: VAR model, GDP growth, Unemployment rate, Sudan.

1. Introduction

Since the first oil shock in the 1970s, the relationship between oil price shocks and macroeconomic activities has received great attention from economists. In pioneering work, Hamilton (1983) claimed that oil price increase had negatively impacted the real GNP in the United States. Similarly, Gisser and Goodwin (1986) argued that oil price had a significant positive impact on the unemployment rate, while its effect on real GNP was negative and statistically significant. These results were further confirmed by Lee *et al*. (1995) and Mork (1989). In studying the impact of oil price shocks on GDP growth in seven OECD countries, Mork *et al*. (1994) suggested that oil price increase caused GDP growth to slowdown in Canada, while in Norway the response was positive for both oil price increase and decrease. In a similar study, Jimenez-Rodriguez and Sanchez (2004)

found that oil price increase had significant positive impact on the GDP growth of Norway, while its effect on the UK GDP growth was negative and statistically significant. This unexpected result is due to the appreciation of the UK exchange rate, which harms its exporting sector (Dutch disease effects). On the other hand, oil price decrease affected the GDP growth of UK and Norway positively. This positive result in the case of Norway was attributable to a prudent economic policy and management of oil windfalls. In another study covering selected European countries, Jimenez-Rodriguez and Sanchez (2009) found that oil price increase had a negative impact on real GDP growth. In assessing the impact of oil price shocks on the Turkish economy, Erkan et al. (2010) pointed out that oil price increase had a significant negative effect on the unemployment and moderately impacted economic output. The negative effect of oil price shock on unemployment rate was confirmed by Dogrul and Ugur (2010). In Iran, Farzanegan and Markwardt (2009) reported that real GDP responded positively to oil price increase, whereas oil price decrease had a negative impact on real GDP. Likewise, Mohsen and Nooshin (2013) suggested that oil price increase positively impacted the GDP growth in Iran. Furthermore, Joseph (2013) and Aliyu (2009) claimed that oil price increase affected GDP growth positively, while decrease negatively impacted it. These positive relationships were consistent with those reported by Mendoza and Vera (2010) Katsuya (2012) in Venezuela and Russia, respectively. The effect of oil price shocks on some of the Middle East and North Africa countries have been examined by Berument et al. (2010). They found that oil price shocks positively impacted GDP growth in the following countries: United Arab Emirates (UAE), Syria, Qatar, Oman, Libya, Kuwait, Iraq, Iran and Algeria.

In Sudan, the period 2000-2011 witnessed a remarkable increase in the real economic growth rate, reaching a peak of 9.3% in 2007. Throughout the period 2000 – 2007 a steady growth was reported with a slight drop in 2003. The increase of real GDP growth rate was due to the advent of oil production and increase in foreign direct investment associated with oil sector activities. During that period, Sudan was classified as among the fastest growing economies in the Sub-Saharan region (World Bank, 2009). From an economic theory point of view, unemployment moves in the opposite direction to the GDP movement. However, there was a general trend of growing unemployment rate. This might be attributed to the characteristics of the oil sector, which is associated with capital intensive rather than labour intensive projects. To this end, this paper aims at investigating the impact of oil price shocks on the real GDP growth and unemployment rates during the period 2000 – 2014.

The remainder of this paper is organized as follows. Section two explains data and methodology. Section three presents the empirical findings and discussion. The conclusion is presented in section four.

2. Methodology and data:

The time series data were obtained from the Central Bank of Sudan (www.cbos.gov.sd). Real oil prices were obtained from the US Energy Information Administration available online at (www.eia.gov). In this research, we adopted non-linear oil price specification proposed by Mork (1989). According to him, oil price change is defined as follows:

$$\text{Positive real oil price (PROILP)} = \begin{cases} O_t \text{ if } O_t > 0 \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

$$\text{Negative real oil price (NROILP)} = \begin{cases} O_t \text{ if } O_t < 0 \\ 0 \text{ otherwise} \end{cases} \quad (2)$$

Where *Ot* is the rate of change in real oil price. It is worth noting that positive and

negative real oil price mean an increase and decrease in real oil price, respectively.

The general unrestricted VAR model is as follow:

$$Y_t = c + \mathbf{\Phi}1y_{t-1} + \mathbf{\Phi}2y_{t-2} + .. + \mathbf{\Phi}p\ y_{t-p} + \boldsymbol{\epsilon}_t \quad (3)$$

Where y_t is (n ×1) vector of endogenous variables; c is (n ×1) vector of constant; $\mathbf{\Phi}_j$ is (n × n) matrix of autoregressive coefficients for j = 1, 2, …, p where p is lag length; and $\boldsymbol{\epsilon}_t$ is (n ×1) vector of white noise term (Hamilton, 1994). Generally speaking, researchers use VAR model to analyse Granger causality, impulse response functions and forecast error variance decomposition analysis. We first test the stationarity and unit root of the series using Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) and cross-checked by Kwiatkowski, Phillips, Schmidt and Shin (KPSS). The null hypothesis of the former two tests is the existence of unit root, while in the latter series are stationary. Using of the stationarity and unit root tests together is known as "confirmatory data analysis" (Brooks, 2002). Instead of testing the three equations for stationary (with constant, constant and trend and no constant and no trend), we plotted the data graphically and visually selected the right equation that would be tested. To determine the appropriate lag length we used the Information criteria approach. Then we tested the VAR adequacy. Upon the validation of the estimated VAR model, we examined the short-run relationships using the Granger causality test (Granger, 1969). Then, we employed the orthogonalised impulse response functions to determine the dynamic responses of the variables to shocks in oil prices, and finally performed the variance decomposition analysis.

3. Empirical findings analysis and discussion

3.1 Unit root and stationary tests

Table 1 shows the result of stationary and unit root tests. ADF and PP tests are based on the null hypothesis of non-stationary in time series data, while KPSS null hypothesis is stationary. The criterion followed here is that at least two tests should give the same result on condition that KPSS should be one of them. When *p*-value is less than 5%, the null hypothesis will be rejected and the alternative hypothesis will be accepted.

As the sample period is short and the number of observations is relatively small, all variable will be used at level in the VAR model. Some scholars claim that using differencing technique to make the variables stationary should be avoided, as it results in losing of some information, which is of beneficial for long run relationship between time series variables (Sims, 1980; Hamilton, 1994; Enders, 1995; Halcoussis, 2005; Brooks, 2008)

Table 1. GDP and unemployment VAR model: stationary tests results

Variables	ADF		PP		KPSS	
	Level	1st. difference	Level	1st. difference	Level	1st. difference
PROILP	0.0027*	-	0.0027*	-	0.3912*	-
NROILP	0.0019*	-	0.0019*	-	0.2198*	-
RGDPG	0.0215*	-	0.6562	-	0.1131*	-
UEM	0.2119	0.0035*	0.2171	0.0035	0.1132	0.1619*

*indicate significance at 5%

3.2 Lag length

Due the short period of the time series data with regard to the GDP growth and unemployment rates which are available on annual base, the recommended VAR model lag is one (Hamilton, 1983, Brooks, 2008.

3.3 Model estimation

Table 2 presents the GDP and employment VAR model estimates using Ordinary Least Square (OLS) method. Each column constitutes an equation in the VAR model. Hamilton (1983), Gisser and Goodwin (1986), Mork (1989), Mork et al. (1994), Lee and Ratti (1995) and Chuku (2012) were used the sign of the coefficients to explain their direction of the effect. That is, negative sign of the coefficient shows negative relationship, while positive sign means positive link. As can be seen from table 2, positive real oil price had a positive relationship with the real GDP growth, but negatively related to the unemployment rate. The negative relationship between positive real oil price and unemployment rate means more jobs will be created during oil price boom. Looking at the negative real oil price shock, it negatively related to the growth rate of the GDP and unemployment rate as well. That is, negative real oil price shock shrank GDP growth rate and reduced unemployment rate. The dummy variable represents the period after the separation of south Sudan, 2012-2014.

Table 2. GDP and unemployment VAR model estimates

Standard errors in ( ) & t-statistics in [ ]

	PROILP	NROILP	RGDPG	UNEM	DUMMY
PROILP(-1)	-0.479086	-0.531590	0.014884	-0.074007	0.139756
	(0.27711)	(0.21551)	(0.04496)	(0.06288)	(0.53583)
	[-1.72888]	[-2.46665]	[0.33103]	[-1.17703]	[0.26082]
NROILP(-1)	0.361659	0.251706	-0.000919	-0.000229	0.396730
	(0.39910)	(0.31039)	(0.06476)	(0.09056)	(0.77172)
	[0.90618]	[0.81094]	[-0.01420]	[-0.00253]	[0.51409]
RGDPG(-1)	1.830262	-1.122137	0.647206	0.381259	-9.172212
	(1.67235)	(1.30061)	(0.27136)	(0.37946)	(3.23371)
	[1.09443]	[-0.86278]	[2.38507]	[1.00475]	[-2.83644]
UNEM(-1)	2.242954	-0.959592	-0.415906	0.494337	-1.212374
	(1.44587)	(1.12447)	(0.23461)	(0.32807)	(2.79579)
	[1.55128]	[-0.85337]	[-1.77276]	[1.50681]	[-0.43364]
DUMMY(-1)	-0.153603	-0.097599	-0.004462	-0.015003	0.497784
	(0.14909)	(0.11595)	(0.02419)	(0.03383)	(0.28828)
	[-1.03030]	[-0.84176]	[-0.18443]	[-0.44350]	[1.72676]
C	-0.232878	0.317654	0.087250	0.072785	0.946054
	(0.32620)	(0.25369)	(0.05293)	(0.07401)	(0.63075)
	[-0.71392]	[1.25214]	[1.64844]	[0.98340]	[1.49990]
R-squared	0.522121	0.550302	0.714458	0.437673	0.823836
S.E. equation	0.117824	0.091633	0.019118	0.026734	0.227828

3.4 Diagnostic tests

For the validation of the VAR model, four tests were carried out, namely serial correlation, heteroskedasticity, stability and normality tests. The outcome was that no serial correlation, no heteroskedasticity, VAR satisfies the stability condition and the VAR model passes the normality test using the Jarque-Bera test.

3.5 Granger causality test

Table 3 displays the outcomes of Granger causality test using Wald statistical test. It is clear that neither positive real oil price nor negative real oil price shocks have a significance influence on the unemployment and real GDP growth rates at 5% significance level. This is evidence from the *p*-value, which greater than 5%. However, there is a bi-directional influence between real GDP growth and unemployment rate at 10% significance level

Table 3. Granger causality test results
Table 1

Dependent variable: RGDPG

Excluded	Chi-sq	df	Prob.
PROILP	0.109580	1	0.7406
NROILP	0.000202	1	0.9887
UNEM	3.142686	1	0.0763
DUMMY	0.034015	1	0.8537
All	3.664602	4	0.4533

Dependent variable: UNEM

Excluded	Chi-sq	df	Prob.
PROILP	1.385397	1	0.2392
NROILP	6.41E-06	1	0.9980
RGDPG	1.009524	1	0.3150
DUMMY	0.196695	1	0.6574
All	4.152642	4	0.3857

3.6 Impulse response functions

Figure 1 shows the impulse response functions for the positive real oil price and negative real oil price over ten years' time horizon. A unit of standard deviation shock is applied to the innovation of both positive and negative oil prices and the effect is traced out on the dependent variables. In order to identify orthogonalised innovations in each equation and the dynamic responses to these shocks, Cholesky decomposition method was used, which was proposed by Doan (1992). This method entails a selection of the ordering of the variables in the VAR model. Variables were arranged from the most exogenous to the less exogenous. Accordingly, the ordering of the variables is set as follows: PROIP, NROILP, RGDPG and UNM. It worth mentioning that dotted lines in the IRFs refer to the confidence bands and when the horizontal line (zero line) falls between the two confidence bands, the impulse response is said to be statistically

insignificant (Dizaji, 2014,). It is apparent that the response of real GDP growth to positive oil price shock was positive and continued that way to the end of the predicted period. The growth of the GDP reached its peak during year two and three. That is, one unit change in the positive oil price resulted in 0.8% increase in the real GDP growth. However, the response of the real GDP growth to negative real oil price shock was negative in the first year and half, but became positive thereafter. These results are consistence with the findings of other studies (Berument et al., 2010; Al-Mulali and Che Normee, 2013). It is worth noting that the real GDP growth retarded by 0.5% in the first year. This result showed that positive oil price shock had greater effect on real GDP growth compared to the negative oil price shocks. Turning to unemployment rate, the positive oil price shock caused unemployment rate to decline through the first two years and half, and then increased through the following years. The unemployment reduced by almost 0.5% in the second year. Looking to the other side of the coin, interestingly decrease in real oil price influenced unemployment rate to decrease during the first three years and half, and then started to increase thereafter. The maximum reduction of 1.5% was observed in the first year. We concluded from the above discussion that positive oil price shock increased the real GDP growth and reduce unemployment rate, whereas negative oil price shock retard real GDP growth and decrease unemployment.

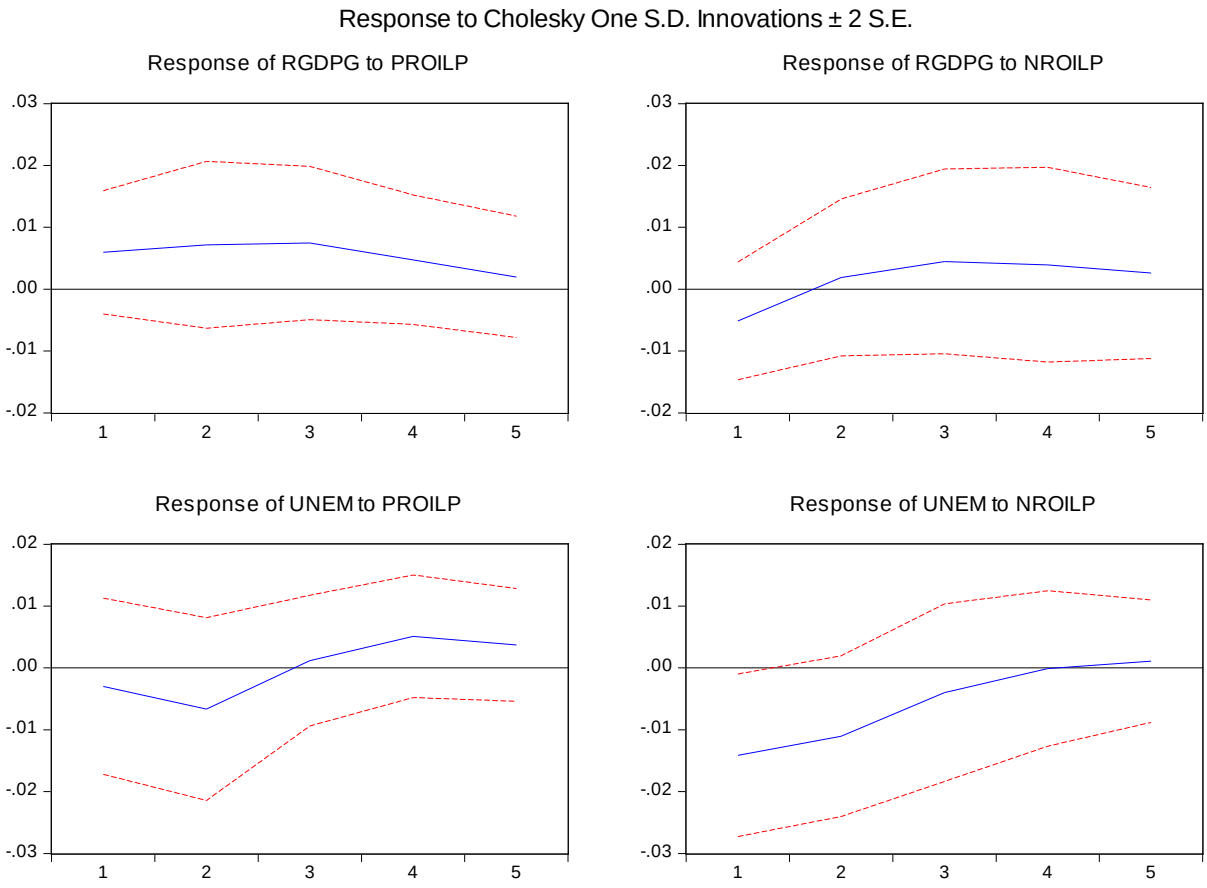

Figure 1. GDP and unemployment VAR model: IRFs of shock to positive and negative real oil price

3.7 Variance decomposition analysis

The variance decomposition of real GDP growth (RGDPG) and unemployment (UNEM) due to their own shock and shock of other variables is shown in table 4. The variance decomposition analysis displays the importance of the variable in

explaining the variations in its own and on other variables in the model as well due to on standard deviation shock. As can be seen from table 4, the importance of the positive real oil price (PROILP) in explaining the variation in the real GDP growth was gradually increasing through the entire period. From year four to the end of the predicted period positive real oil price accounted for 14.8% of the variations in real GDP growth. Unlike the ROILP, the negative real oil price (NROILP) was responsible of almost 7.2% of the variation in the RGDPG in the first year. In the second year, the contribution of NROILP decreased to 3.9%, and then started to increase gradually reaching 6.4% by the end of the forecasted. This result showed that negative real oil price shock had relatively lesser explanatory power in the real GDP growth compared to increase in real oil prices. On the other side of the coin, shock of the RGDPG had significant proportion in the variations of its own value in the first year amounting to 83.1%. But this explanatory power drops to 63.2% at the end of the forecasted period. For the UNEM, it contributed to the variation in RGDPG in the second year by almost 9%, then its contribution increased slightly to 15.6% in the last year. On the other hand, positive real oil price shocks were responsible at maximum for 7.8% of the variation in the unemployment, while negative real oil price accounted of more than 27.9% of the variations. That is, negative oil price had greater explanatory power on unemployment compared to positive real oil price shocks. This might be attributed to combination of factors after the separation: loss of 20% of the population, mass migration to Gulf and other countries and new recruitment policy adopted by the government.

Table 4. GDP and unemployment VAR model: error forecast decomposition analysis

Variance Decomposition of RGDPG:						
Period	S.E.	PROILP	NROILP	RGDPG	UNEM	DUMMY
1	0.117824	9.681230	7.234657	83.08411	0.000000	0.000000
2	0.132116	11.51071	3.984853	75.39973	9.047705	0.057002
3	0.144276	13.98365	4.914488	67.42153	13.63577	0.044565
4	0.157409	14.81266	5.886596	64.16676	15.09186	0.042130
5	0.162789	14.86002	6.364426	63.16035	15.57229	0.042910
Variance Decomposition of UNEM:						
1	0.091633	1.243401	27.93689	19.46673	51.35298	0.000000
2	0.106266	5.570697	33.50223	14.59737	45.82450	0.505208
3	0.111280	5.216492	32.13264	20.06248	42.07161	0.516773
4	0.115181	7.009443	29.28673	23.95502	39.27674	0.472079
5	0.119863	7.791550	27.94024	25.62715	38.18061	0.460456

4. Conclusion

This paper aimed at exploring the effect of oil price shocks on two key macroeconomic indicators in Sudan. The research used a Vector Autoregression model proposed by Sim (1980) to examine the relationship over the period 2000 – 2014, using annual data. The empirical outcomes of the Granger causality test suggested that unemployment significantly Granger caused GDP growth rate at 10% significance level. The results that obtained from the impulse response functions and the variance decomposition analysis suggested that the effect of oil price shocks was almost symmetrical with regard to GDP growth rate. However, negative oil price shock had shown a significant negative impact on the unemployment rate. This might be attributed to the coincidence of number of

factors (1) drop of oil prices in the last three years of the sample period (2) government recruitment policy (3) huge migration to Gulf and other countries (4) separation of south Sudan.

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